Thüringer Landessternwarte Tautenburg

Press Release 14.11.2016

Watching a Massive Star grow

Astronomers of the Thüringer Landessternwarte Tautenburg who teamed up with other scientists observed for the first time a strong growth episode of a young, massive star. Thereby, they found evidence that massive stars may form like their low-mass brethren, by accreting matter from a circumstellar disk.

Nowadays, important discoveries in astrophysics are often being made by collaborations of scientists from many countries. That also holds for the case of the young massive star which astronomers from Thuringia succeeded to observe. Japanese radio astronomers announced in 2015 November an increase of a certain radio emission coming from the direction of the star cluster S255IR. This raised the attention of Dr. Alessio Caratti o Garatti from the Dublin Institute for Advanced Studies, Section Astronomy and Astrophysics, and his collaborators. Caratti o Garatti, a former PostDoc of the Thüringer Landessternwarte (TLS), cooperates with Dr. Bringfried Stecklum and Dr. Jochen Eislöffel, both staff members of TLS.

The team had the suspicion that the radio signal might be related to the increase of the heat radiation from a massive star. That's why they used the PANIC (Panoramic Near Infrared Camera) instrument at the 2.2-m telescope of the Calar Alto observatory in southern Spain to get current infrared images of S255IR. The comparison of the new images, taken end of November 2015, with archival data from 2009 showed that the object NIRS3 brightened substantially (Fig. 1). Remarkably, NIRS is a young star with a mass of about 20 solar masses. In order to investigate this unique brightness outburst the team applied for follow-up measurements at various observatories, e.g. the airborne SOFIA (Stratospheric Observatory for Infrared Astronomy).

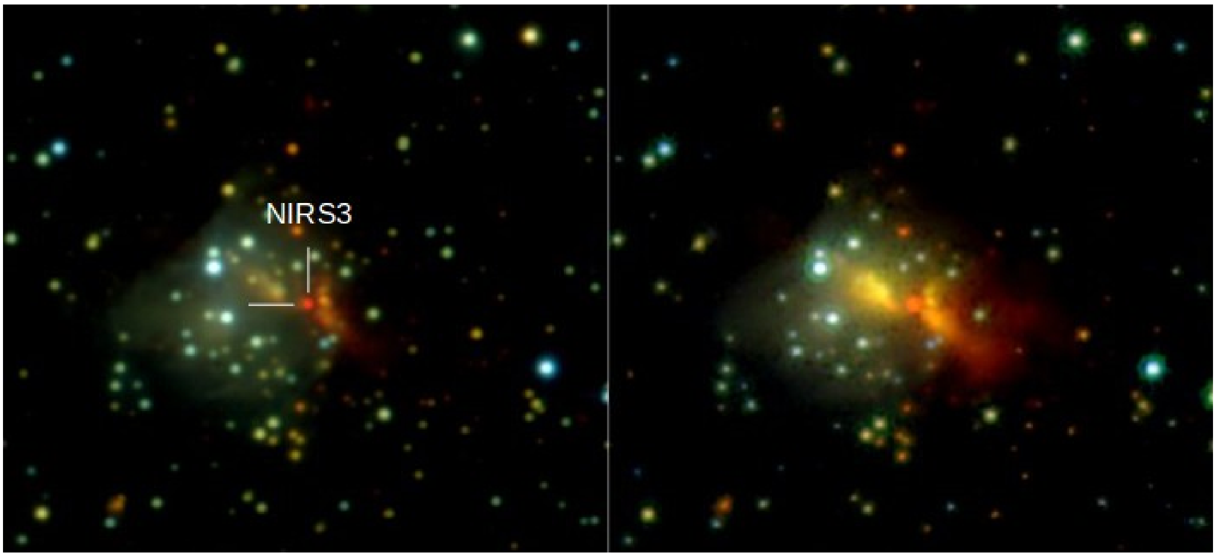

Figure 1: Near-infrared images of the star cluster S255IR taken in 2009 (left) and 2015 (right). NIRS3 is the red source in between the two conical nebula.

How Stars form from Gas and Dust

Stars form when a gas/dust cloud looses its equilibrium and collapses under its own weight. This leads to the formation of proto-stars in the densest regions of the cloud which are surrounded by circumstellar disks and envelopes. Matter falls from the envelope onto the disk, moves inward due to the gravitational pull, and eventually falls onto the proto-star. Thus, the young star grows in mass. The energy released when the matter smashes onto the star is being radiated away.

A fraction of the matter, however, misses to reach the proto-star but is being ejected along its rotational axes at high speeds. This is what astronomers call jets or outflows. Such outflows can clear out the polar regions from gas and dust which allows the stellar light to escape especially well into these directions.

The non-steady Growth of Stars

It is already known for some time that stars like our Sun grew non-steadily at their birth. During brief episodes low-mass young stars collect much more matter than is usually the case. Since the energy release is higher then, both the star and the associated nebula appear much brighter. For the first time the scientists were now able to observe the same phenomenon in case of a very massive object such as NIRS3.

By looking carefully at the infrared images taken at different epochs, they noticed a systematic change of the brightness of the nebula. At first the region facing the Earth got brighter but then the opposite region rose in brightness. The astronomers explain this finding by the time the light takes to travel from the young star to dust grains in the nebula which redirect it toward the Earth. Like the echo of shouts in the mountains this represents the light echo of the outburst from NIRS3.

The temporal change of the light echo allowed the researchers to date the onset of the outburst which happened end of June 2015 and led to the increase of the radio signal. However, since NIRS3 is about 6000 light years away the event which was witnessed now already belongs to the past of the object. The source cannot be seen in the optical since it is embedded in a gas and dust cloud. Therefore, infrared and radio observations are required to reveal its secrets.

Figure 2: SOFIA is a modified Boeing „Jumbo-Jet“ equipped with a 2,5-m telescope to measure infrared radiation which cannot penetrate Earth's atmosphere. The observations of NIRS3 were performed during two flights in spring 2016 (picture ©NASA).

Measurements using the airborne observatory SOFIA (Fig. 2) which is being operated jointly by both the US space agency NASA and the Deutsches Zentrum für Luft- und Raumfahrt (DLR) yielded an estimate of the total energy released by the burst. Within the period of the burst of nearly a year NIRS3 emitted the same amount of energy as our Sun does within 100,000 years. Similarly stunning is the mass increase of the young star within that time which amounts to about twice the mass of Jupiter.

Main results of these investigations were published on 2016 November 14 in the journal “Nature Physics”. Bringfried Stecklum from the Thüringer Landessternwarte summarizes “We were very lucky to detect this outburst which yielded amazing results. The observations of NIRS3 are still ongoing and we expect further interesting findings. This is very exciting.“.

Media Contact:

Dr. Bringfried Stecklum, Dr. Jochen Eislöffel
Thüringer Landessternwarte
Telefon: +49-36427-863-54
E-Mail: stecklum at tls-tautenburg.de

Original Publication:

A. Caratti o Garatti, B. Stecklum, R. Garcia Lopez, J. Eislöffel, T. P. Ray, A. Sanna, R. Cesaroni, C. M.Walmsley, R. D. Oudmaijer,W. J. deWit, L. Moscadelli, J. Greiner, A. Krabbe, C. Fischer, R. Klein and J. M. Ibañez (2016): Disk-mediated accretion burst in a high-mass young stellar object. Nature, DOI: 10.1038/nphys3942

Read-only access via the Springer Nature Content Sharing Initiative

Links related to this Press Release:

Press Release of the Calar Alto Observatory

Press Release of the German SOFIA Institute

Press Release of the Gemini-Observatory

Press Release of Istituto Nazionale di Astrofisica (INAF)

TLS Press Release on the detection of a burst from a very low-mass young star (in German)